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(54) **Ultrasonic inhaler**

(57) An ultrasonic inhaler consists of a housing 1, a breathing mask 2 and a resonator head 4 adapted to receive inhalant from a collapsible container 5. The housing contains a frequency generator 3 which is connected to the head 4 by pin and socket connections 9, 15. The head 4 consists of a resonator 6 and a terminal board 7 which are encapsulated in a casing 11 for cleaning and sterilisation. The head includes an array of projecting pins and different heads have different connections between the pins 9 and the resonator so that heads can be interchanged for different frequencies, the correct frequency being tapped off from the multi-frequency generator.

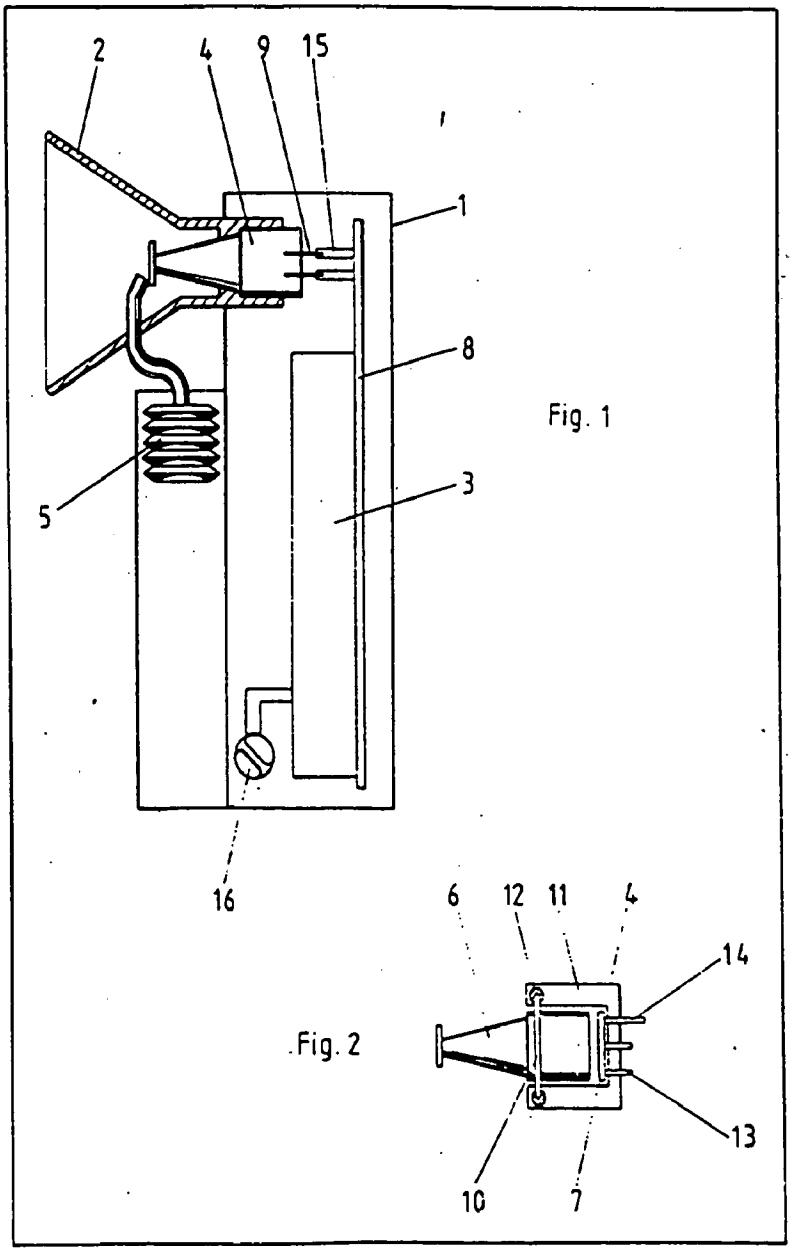

Fig. 1

Fig. 2

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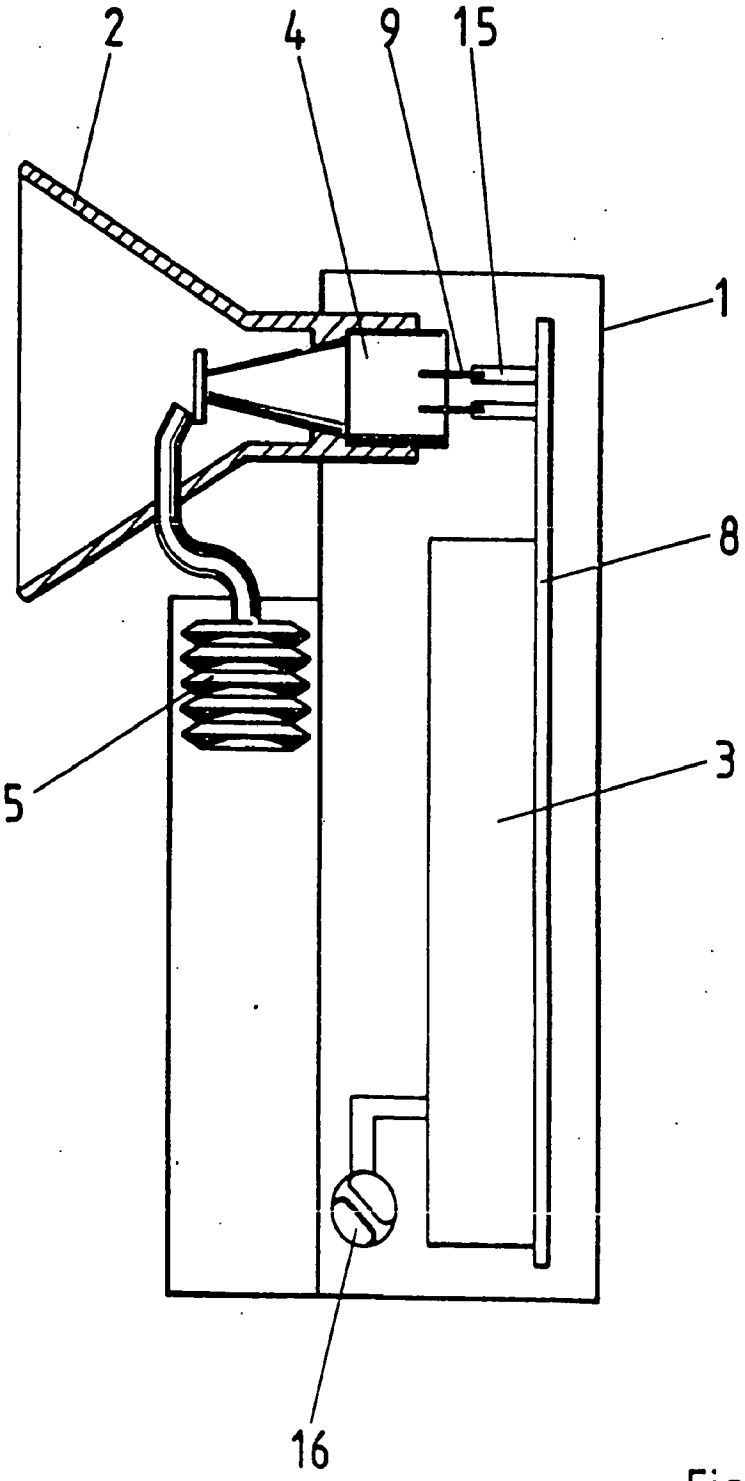

Fig. 1

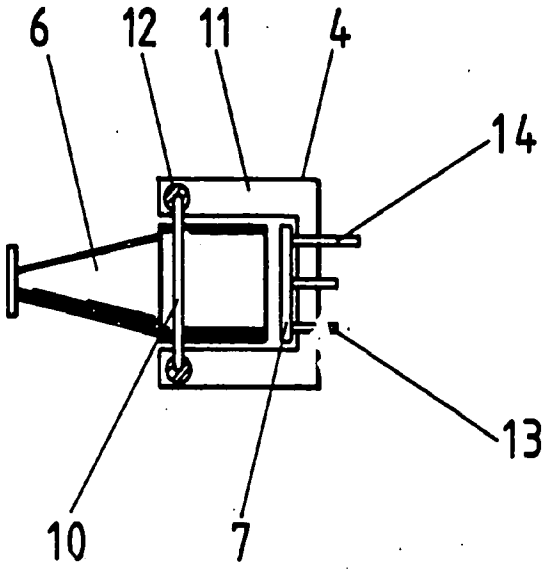

Fig. 2

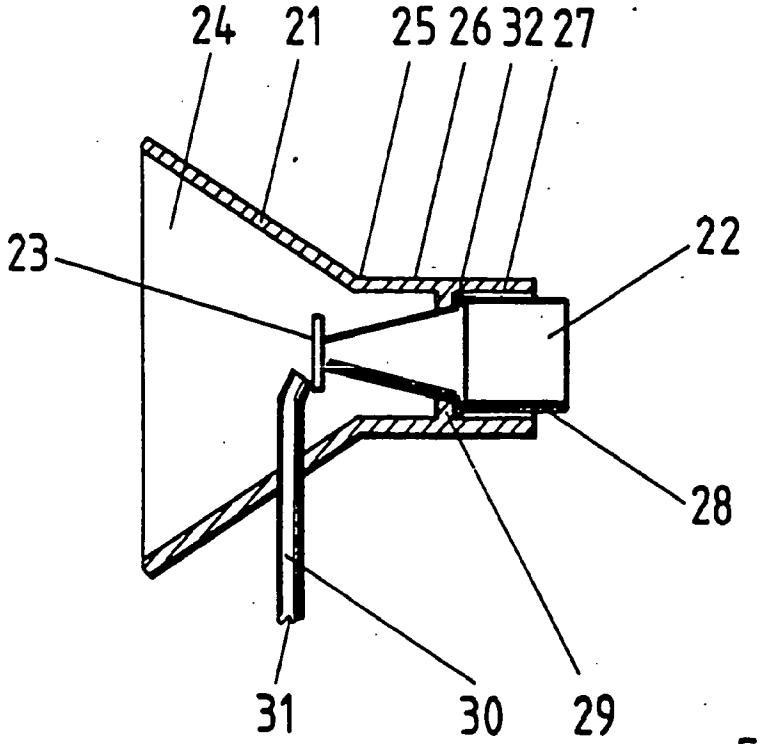

Fig. 3

SPECIFICATION
Ultrasonic inhaler

The invention relates to an ultrasonic inhaler, consisting of a housing with a breathing mask, a frequency generator, a resonator head and an inhalant container with means for transporting liquid to the resonator head.

Inhalers for treating the respiratory tract and the pharyngeal cavity are already known, wherein the inhalant is vaporised on a resonator head energised by ultrasound. Resonator heads of this kind are also known as ultrasonic atomisers. The mist with a constant droplet size produced by the atomisation of the inhalant acts on the mucous membranes in the nasopharynx, or on the surfaces of the blood vessels in the lungs, when inhaled more deeply into the respiratory tract, depending on the diameter of the droplets. In the known apparatus, used in the treatment of diseases such as colds, catarrh, sore throats, coughs, asthma, bronchitis etc., with their various symptoms, the droplet size of the aerosol produced cannot be varied. The aerosols have only a specific range of effect, depending on the size of the individual droplets. The resonator head fixedly incorporated in the inhaler produces an inhalant mist with a specific droplet diameter which acts either on the nasal cavity or on the throat region or in the lungs. To produce aerosols with different droplet sizes, a number of inhalers are needed. Only a certain area of the respiratory tract can be treated with any one inhaler. One feature of the known ultrasonic inhalers which has proved exceptionally disadvantageous is that the resonators are fixedly connected to the inhalation apparatus and the apparatus as a whole cannot be sterilised because of the electrical equipment which it contains. The difficulty in sterilising the known apparatus has resulted in infections of oral pharyngeal cavity in different users.

The object of the invention in one of its aspects is to provide an ultrasonic inhaler which does not have the disadvantages of the known inhalers, and which can be used to vaporise inhalants of different viscosities, to treat all regions of the respiratory tract (nose, throat, lungs) and wherein the most important parts, namely, the resonator and breathing mask, can be sterilised.

According to this aspect of the invention there is provided an ultrasonic inhaler, comprising a housing with a breathing mask, a frequency generator, a resonator head and inhalant container with means for transporting liquid to the resonator head in which the resonator head consists of a resonator and head terminal board encapsulated in fluidtight manner, the electronic frequency generator being adapted to deliver at least two different output frequencies, which are applied to an output terminal board, the head printed circuit board and output terminal board being releasably connected to each other by means of a plug connection.

This makes it possible to operate different ultrasonic resonators with a single inhalation apparatus. By means of the plug connection, the correct exciting frequency of the frequency generator which excites the resonator head is tapped, so that the particular aerosols required for optimum therapeutic success, depending on the particular inhalant and the region of the respiratory tract to be treated, is produced in the apparatus. This ensures that pre-determined areas of the respiratory tract can be specifically treated with the inhalant. The resonator is selected before the treatment, in accordance with the required diameter of the individual drops of aerosols, and this resonator is connected to the frequency generator via the plugs of the connector pair with the socket mounted inside the housing, and the frequency which excites the resonator is thereby tapped. After the apparatus has been used, the resonator head can be removed and then sterilised, together with the breathing mask. The pressuretight encapsulation of the resonator head prevents any moisture from penetrating into the resonator head.

In a preferred embodiment, a flange is formed on the outside of the resonator head and an elastically deformable seal is provided between the flange and the housing. This seal is conveniently mounted in a nodal point of oscillation. This is particularly advantageous, since the mechanical ultrasonic energy from the resonator is released via the fixing flange of the resonator head.

In a further preferred embodiment of the invention, a plurality of plug pins are secured in the head terminal plate. At least one plug pin projects beyond the other plug pins and the sockets corresponding to these plug pins are mounted on the output printed circuit board. This avoids the use of a multi-stage switch. Obviously, it is also possible to generate the different frequencies required by means of a reversing switch. However, this is exceptionally laborious, since a total of twelve contacts have to brought into specific arrangement relative to one another in order to generate the required frequency. The fact that one plug pin is longer than the others prevents the resonator head from being plugged incorrectly. An additional safeguard is provided by an eccentric arrangement of the plug pins and the provision of an additional stop lug.

A further aspect of the invention is concerned with the breathing mask itself. Whilst ultrasonic inhalers with a removable breathing mask are known in general these masks are releasably connected to the housing of the ultrasonic inhaler and, on the side of the mask facing the user's face, they have an outer contour adapted to the shape of the human face. The resonator partially passes through the breathing mask, with the resonator head and the atomiser plate. The atomising of the inhalant on the atomiser plate of the resonator head is effected in the cup-shaped interior of the breathing mask.

A disadvantage of the known breathing masks for ultrasonic inhalers is the fact that, when different resonator heads are used in one

ultrasonic inhalation apparatus, the ultrasonic resonators with their atomiser plate project to different distances into the interior of the breathing mask. The reason for this is that the individual resonator heads have to be different lengths in order to generate different frequencies.

The aim of this aspect of the invention is to provide a breathing mask for an ultrasonic inhaler which does not have the disadvantages mentioned above and wherein the atomiser plate of the resonator extends the same distance into the interior of the breathing mask, irrespective of the length of the resonator head. This aim is achieved by the fact that, on the outer surface of the mask, in the region of the resonator, a tubular extension is formed, the inner diameter of the extension is equal to or greater than the external diameter of the resonator, a stop is formed in the interior of the extension and the mask has an opening for the inahalant transporting means. According to a further feature of the novelty, the stop is of annular configuration, whilst there is an elastically deformable oscillation attenuator resting between the stop and resonator.

In this way, it is ensured that the resonator plate always extends the same distance into the interior of the breathing mask, despite the differences in length of the resonator head used. Thus the resonator head is always the same distance from the user's respiratory orifices. The actual breathing mask is pushed with its flange on to the resonator and held on the resonator head during use. The stop formed in the interior of the extension ensures that the resonator atomiser plate always extends the same distance into the cup-shaped interior of the breathing mask. This is completely independent of the length of the resonator head. The opening provided in the mask enables the inhalant to be conveyed unimpeded from the inhalant container to the resonator atomiser plate. In a preferred embodiment the stop is of annular formation and an elastically deformable oscillation attenuator is provided between the stop and the resonator which prevents any oscillations produced by the resonator from being transmitted to the breathing mask.

Embodiments by way of an example of the invention are shown in Figures 1, 2 and 3 and described more fully hereinafter.

Figure 1 schematically shows the structure of an ultrasonic inhalation apparatus.

Figure 2 shows a section through a resonator encapsulated in fluidtight manner according to the invention, and

Figure 3 shows a further embodiment of breathing mask.

The ultrasonic inhaler consists of the housing 1 and a breathing mask 2. Mounted in the housing are the frequency generator 3, the resonator head 4 and the inhalant container 5 with means for transporting liquid to the resonator head 4. The breathing mask is fitted on the resonator head and is held by the latter. The resonator head 4 consists of the resonator 6 and the head terminal plate 7. The resonator 6 and the head terminal plate 7 are encapsulated in fluidtight manner. The frequency generator 3 accommodated in the housing 1 delivers at least two different output frequencies. The electronic frequency generator is mounted on an output terminal plate 8. Sockets 15 to which the output frequencies of the electronic frequency generator 3 are applied are fixed in this output terminal plate.

A flange 10 is formed on the outside of the resonator head 4. Between the flange 10 and the casing 11 there is an elastically deformable seal 12. This ensures that the removable resonator head 4 is encapsulated in fluidtight manner. Thus, it is possible to remove the resonator head from the ultrasonic inhaler after each use and subject it to thorough disinfection.

Mounted in the head terminal plate 7 are a plurality of plug pins 13, one of which 14 projects beyond the other plug pins 13. This ensures that all the plug pins 13, 14 can be connected to the corresponding plug sockets 15 in the output terminal plate 8.

The resonator head plate 7 is located on the side of the resonator 6 remote from the frustum end. The printed conductor side of the plate 7 faces the resonator 6. On the head plate 7 there is a total of twelve plug pins 13, 14 which are soldered into the head printed circuit, and the free ends of which project out of the resonator head 4, which is enclosed in fluidtight manner. The plug pins 13, 14 engage in the corresponding plug sockets in the output plate 8. Of the twelve plug pins in the resonator head plate only two plug pins are connected to the resonator 6. The other ten are connected to one another by printed conductors so that, in the plugged-in state in which the plug pins and sockets are connected, the printed conductors of the output plate 8 are interconnected in a specific manner, so as to generate the frequency needed to excite the resonator head 4.

The special arrangement of the resonator head plate 7 makes it unnecessary to use a multi-stage reversing switch 16. Of course, it is also possible to generate the different frequencies by the use of a reversing switch 16, but this is exceptionally laborious since a total of 12 contacts have to be brought into specific arrangements relative to one another in order to generate a predetermined frequency. Thanks to the special arrangement of the head plate 7 and the output plate 8 it is possible to tap the frequency required to excite the resonator head 4 from the electronic frequency generator 3 without any additional means.

When the ultrasonic inhalation apparatus is used, the resonator head 4 is made to oscillate by the energy released by the oscillation generator 3. At the same time, inhalant is taken from the inhalant container 5 and supplied to the resonator head 4 where it is vaporised.

Turning now to Fig. 3 there is shown a further embodiment of breathing mask which may be used with the apparatus of Fig. 1. In this embodiment the mask is designated 21 and is

adapted to receive one of a plurality of resonators 22 whose leading edge mounts a resonator atomiser plate 23.

The main body 24 of the mask is extended at 25 to form a tubular extension 26, which receives the resonator 22. The internal diameter 27 of the extension 26 is the same as or slightly greater than the external diameter 28 of the body of the resonator 22 so as to receive it snugly therein.

An annular abutment or stop in the form of flange 29 is formed in the interior of the extension 26 and defines a forward abutment for the resonators 22 so that even though their main bodies may vary in size the leading ends project the same distance into the interior 24 of the mask. Between the flange 29 and the resonator 22 is interposed an elastically deformable oscillation attenuator 32 which reduces the transmission of oscillations to the mask 21.

The body of the mask 21 is formed with an opening 30 which receives the duct 31 of an inhalant transporting means to deliver inhalant to the atomiser plate 23.

CLAIMS

1. An ultrasonic inhaler, comprising a housing with a breathing mask, a frequency generator, a resonator head and inhalant container with means for transporting liquid to the reonctor head in which the resonator head consists of a resonator and head terminal board encapsulated in fluidtight manner, the electronic frequency generator being adapted to deliver at least two different output frequencies, which are applied to an output terminal board, the head printed circuit board and output terminal board being releasably connected to each other by means of a plug connection.

2. An ultrasonic inhaler according to claim 1, in which a flange is formed on the outside of the resonator head and an elastically deformable seal is provided between the flange and the housing.

3. An ultrasonic inhaler according to claim 1 or 2, in which a plurality of plug pins are fixed in the head terminal board at least one of which projects beyond the other and the co-operating plug sockets are fixed on the output terminal board.

4. An ultrasonic inhaler according to any of the preceding claims in which a reversing switch is operatively electrically connected to the frequency generator.

5. An ultrasonic inhaler having a removable breathing mask and comprising a resonator which passes through the mask and the resonator atomiser plate opening out in the interior of the mask, in which a tubular extension is formed on the outer surface of the mask in the region of the resonator, the internal diameter of the flange being equal to or greater than the external diameter of the resonator, a stop is formed in the interior of the extension and an opening being provided for receiving inhalant transporting means.

6. An ultrasonic inhaler according to claim 5, in which the stop is of annular formation and an elastically deformable oscillation attenuator is disposed between the stop and the resonator.

7. An ultrasonic inhaler substantially as hereinbefore described with reference to the accompanying drawings.

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